DS 28: Trends in Ion Beam Technology: From the Fundamentals to the Application

Time: Thursday 16:15–17:45 Location: H 2013

DS 28.1 Thu 16:15 H 2013

Epitaxial TiN film deposition at different substrate temperatures using hyperthermal titanium ions — •J. W. Gerlach, A. Wolfsteller, T. Höche, and B. Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstrasse 15, 04318 Leipzig

Conventional ion beam assisted deposition (IBAD) of binary nitrides, e.g. TiN, is usually done by evaporation of the metal component and simultaneous nitrogen ion irradiation of the growing film. In the literature, a lot of consequences of this ion irradiation during film growth are reported like densification, enlargement of the crystallite size, change of the preferred orientation, biaxial texturing of the films, and others. Contrary, in the present contribution the growth of thin TiN films by deposition of titanium ions, possessing hyperthermal energies of several ten eV, in a nitrogen ambient is investigated. These hyperthermal titanium ions were produced by a pulsed dc vacuum arc metal plasma source. The TiN films were deposited at substrate temperatures in the range from 700 °C down to room temperature on Al_2O_3(0001) and MgO(100) substrates. The surface structure of the films was monitored in situ by RHEED. The crystallographic structure and texture was investigated by XRD. High resolution TEM was used to examine the morphology and defect structure of the films. The results show that all the deposited TiN films are epitaxial, even at RT, indicating the beneficial effect of the hyperthermal energy of the particles involved in the deposition process. The influence of the hyperthermal titanium ion irradiation on the crystalline quality of the films is discussed.

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Ion beam synthesis of Mn/Sb clusters in silicon — •Michael Steinert[1], Andreas Undisz[2], Markus Rettenmayr[2], and Werner Wesch[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena — [2]Institut für Materialwissenschaft und Werkstofftechnologie, Friedrich-Schiller-Universität Jena

Sequential ion implantation was used to incorporate Mn and Sb ions at high fluences of $1\times10^{16}\,at/cm^2$ and $2\times10^{16}\,at/cm^2$, respectively, into weak p-type Si (0 0 1). The implantation was performed at temperatures of $200\,^{\circ}C$ and $350\,^{\circ}C$ with energies of $180\,keV$ (Mn) and $350\,keV$ (Sb). Channeling-RBS measurements carried out before and after a subsequent thermal treatment via rapid thermal annealing (RTA) at temperatures from $950\,^{\circ}C$ to $1350\,^{\circ}C$ for $30\,s$ indicate a strong temperature dependent redistribution of the implanted species during the annealing process governed by the radiation caused defects. An increase of the c-RBS backscattering yield of Sb in all annealed samples suggests the formation of Sb-based clusters. Additionally performed cross-sectional TEM analyses, including EDX measurements, clearly show the presence of hexagonal shaped elementary Sb precipitates as well as compound-clusters consisting of Mn and Sb, which are aligned to the crystal structure of the host silicon. High resolution TEM indicates different crystalline phases inside the observed particles, for the most part deviating in orientation and atomic plane distance from the Si-matrix.

DS 28.3 Thu 16:45 H 2013

Diffusion contrasts of Gold in Silicon induced by ion bombardment — Xiangzun Wang, •Moritz Trautvetter, Andreas Klimmer, and Paul Ziemann — Universität Ulm

As has been demonstrated previously, the diffusion of Au at 250°C is clearly enhanced in amorphous (a-)Si as compared to that in (001)-oriented Si wafers [1]. This effect can be exploited to 'write' diffusion contrast patterns by ion bombardment through a mask leading to the local formation of a-Si. In this way, after subsequent annealing at an optimized temperature, a selective diffusion of Au into the amorphized parts can be accomplished which then exhibit a drastically enhanced electrical conductivity. In the present contribution, the lateral selective diffusion of Au will be demonstrated starting from a Au-covered part of the Si wafer into uncovered but ion bombarded parts of Si. Such experiments allow determination of the electrical conductivity of the Au containing parts.

[1] J. Ehrhardt, A. Klimmer, J. Eisenmenger, Th. Müller, H.-G. Boyen, P. Ziemann:Influence of ion induced amorphicity on the diffusion of gold into silicon, J. Appl. Phys. 100, 063534 (2006)

DS 28.4 Thu 17:00 H 2013

cavity layer introduction in SIMOX technology — •Xin Ou, Reinhard Kögler, Arndt Mücklich, Wolfgang Skorupa, and Wolfhard Möller — Institute of Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, PO Box 51 01 19, 01314 Dresden, Germany

Silicon On Insulator (SOI) is the next generation of integrated circuit technology and Separation by Implantation Oxygen (SIMOX) is one of the mainstream processes for SOI wafer fabrication. The high-dose oxygen implantation in commercial SIMOX process is the main disadvantage considering the wafer cost and quality. In this case, defect engineering is performed in SIMOX process, by introducing a cavity layer as a Oxygen gettering layer using low dose He, H in combination to O implantation and Internal Thermal OXidaiton (ITOX). The cavity layer will narrow the oxygen profile, enhance the growth rate of SiO_2 precipitates, and produce the vacancy defects recombining with the Oxidation released interstitials and reducing the strain in top Si layer. In this project, the width of the cavity layer, cavity size and position distribution, the percentage of empty volume are investigated in order to optimize the Oxygen gettering ability of the cavity layers by Transmission Electron Microscopy (TEM), Auger Electron Spectroscopy (AES), Fourier Transformed Infrared (FTIR) and Scanning Spreading Resistance Microscopy (SSRM). The thermodynamics and kinetics of the SiO_2 precipitates formation and the interaction between the SiO_2 precipitation and defects introduced by Oxygen and extra implantation were studied.

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Controlled self-organization due to sputtering on Si surfaces by lithographic pre-patterning — •Bashkim Ziberi, Theresa Lutz, Renate Fechner, Dietmar Hirsch, Klaus Zimmer, Frank Frost, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e. V.

Pattern formation on the surface of different materials due to low-energy ion beam erosion is a versatile tool for large scale nanostructuring. However, usually this self-organization process lacks long-range ordering and a positional control of the evolving structures. One possibility to influence the ordering and lateral positioning of structures is by using pre-patterned substrate. In this way due to spatial limitations and guided by the lateral ordering of the pre-patterned templates the evolving topography shows an improved ordering, a fabrication principle also known as guided self-organization. In this contribution results on the ripple and dot pattern formation on pre-patterned Si surfaces during low energy (≤ 2000 eV) Kr^{+}+ and Xe^{+} ion beam erosion are presented. The pre-patterned substrates are fabricated by various lithographic techniques in combination with etching techniques for structure transfer. Depending on the shape of the pre-patterned structure different results are obtained. Examples are: i) formation of curved ripples on the surface, ii) perfectly square ordered dots on exact positions on the surface; iii) enhanced ordering of ripples and the formation of ripples with different orientation depending on the local surface orientation. iv) continuous and controlled change in orientation of ripples independent of the ion beam direction.

DS 28.6 Thu 17:30 H 2013

SAXS studies of ion-beam induced nano-sized silver metal clusters in glass — •Ivo Zizak[1,2], Heinz-Eberhard Mahnke[1,3], and Vasil Koteski[1,4] — [1]Hahn-Meitner-Institute Berlin GmbH, Berlin, Germany — [2]Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung mbh, Berlin, Germany — [3]Freie Universität Berlin, Berlin, Germany — [4]Vinca Institute, Belgrade, Serbia

In soda lime glass metallic nano-clusters are produced by incorporating the metal ions via ion exchange processes and subsequent energy input for reducing the ions to metal. By irradiation with swift heavy ions the resultant nanometer sized Ag metal clusters were found to be arranged in chains parallel to the direction of the ion beam [1,2]. For a more detailed and more quantitative study of the arrangement, the shape of the clusters, and the formation process, we have started small angle x-ray scattering (SAXS) experiments at the 7-Tesla-multipole-wiggler beam line at BESSY. The first SAXS images confirm the diameter of the Ag- metal droplets observed in transmission electron microscopy images. In an in-situ experiment during annealing with increasing temperature from room temperature up to 340°C (at this temperature Ag

was incorporated by ion exchange) two fractions of scattering centers, increasing with rising temperature, are observed, which are assigned to clusters arranging in chains and clusters homogeneously distributed over the sample volume.

[1] J.J. Penninkhof et al., Appl. Phys. Lett. 83 (2003) 4137
[2] H.-E. Mahnke et al., Nucl. Instr. and Meth. B 245 (2006) 222